



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 10, 2026 – 07:26 AM UTC

PDB ID : 6LCU / pdb_00006lcu
Title : structure of maltooligosyltrehalose synthase from *Arthrobacter ramosus*
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Deposited on : 2019-11-20
Resolution : 2.45 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

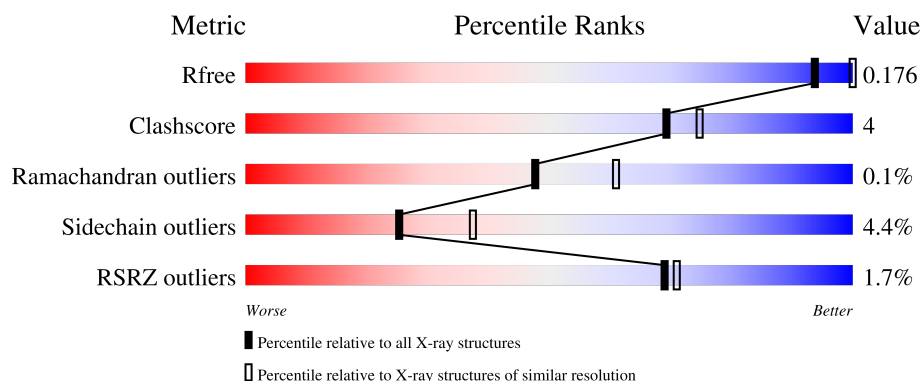
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.45 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	1190 (2.46-2.46)
Clashscore	190562	1229 (2.46-2.46)
Ramachandran outliers	187476	1218 (2.46-2.46)
Sidechain outliers	187428	1218 (2.46-2.46)
RSRZ outliers	180081	1190 (2.46-2.46)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	770	

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 6454 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called MTSase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	756	5879	3685	1079	1109	6	0	0	0

There are 13 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	758	LYS	-	expression tag	UNP Q9AJN7
A	759	LEU	-	expression tag	UNP Q9AJN7
A	760	ALA	-	expression tag	UNP Q9AJN7
A	761	ALA	-	expression tag	UNP Q9AJN7
A	762	ALA	-	expression tag	UNP Q9AJN7
A	763	LEU	-	expression tag	UNP Q9AJN7
A	764	GLU	-	expression tag	UNP Q9AJN7
A	765	HIS	-	expression tag	UNP Q9AJN7
A	766	HIS	-	expression tag	UNP Q9AJN7
A	767	HIS	-	expression tag	UNP Q9AJN7
A	768	HIS	-	expression tag	UNP Q9AJN7
A	769	HIS	-	expression tag	UNP Q9AJN7
A	770	HIS	-	expression tag	UNP Q9AJN7

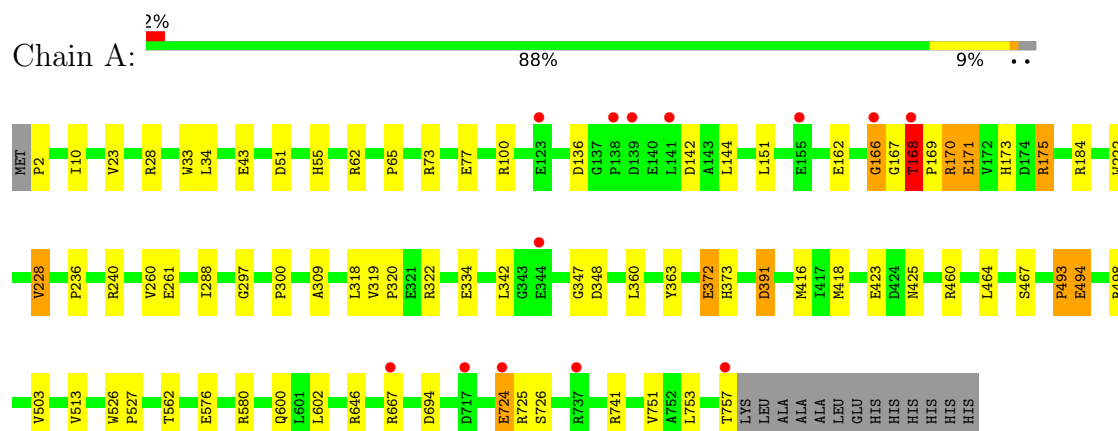
- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	575	Total	O	0	0
			575	575		

3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: MTSase



4 Data and refinement statistics

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α , β , γ	195.43Å 195.43Å 197.73Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	50.00 – 2.45 50.00 – 2.45	Depositor EDS
% Data completeness (in resolution range)	100.0 (50.00-2.45) 99.5 (50.00-2.45)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.01 (at 2.45Å)	Xtriage
Refinement program	PHENIX 1.15.2_3472	Depositor
R, R_{free}	0.154 , 0.178 0.153 , 0.176	Depositor DCC
R_{free} test set	4113 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å ²)	38.9	Xtriage
Anisotropy	0.023	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 54.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	6454	wwPDB-VP
Average B, all atoms (Å ²)	44.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.50% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality [i](#)

5.1 Standard geometry [i](#)

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z > 5$	RMSZ	$\# Z > 5$
1	A	0.54	3/6012 (0.0%)	0.67	3/8187 (0.0%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	65	PRO	C-O	-7.46	1.15	1.24
1	A	460	ARG	C-O	-5.90	1.17	1.24
1	A	493	PRO	C-O	-5.15	1.17	1.24

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	166	GLY	CA-C-N	-6.32	117.36	121.65
1	A	166	GLY	C-N-CA	-6.32	117.36	121.65
1	A	167	GLY	CA-C-O	-6.29	116.03	120.94

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	5879	0	5734	41	0
2	A	575	0	0	8	0
All	All	6454	0	5734	41	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 4.

All (41) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:363:TYR:OH	1:A:423:GLU:OE1	2.00	0.78
1:A:222:TRP:HB3	1:A:228:VAL:HG13	1.71	0.71
1:A:322:ARG:HD3	1:A:425:ASN:OD1	1.92	0.69
1:A:142:ASP:OD2	1:A:170:ARG:NH1	2.27	0.68
1:A:100:ARG:NH1	2:A:802:HOH:O	2.27	0.67
1:A:10:ILE:HG22	1:A:62:ARG:HG2	1.78	0.65
1:A:526:TRP:CD2	1:A:527:PRO:HA	2.38	0.59
1:A:55:HIS:HE1	2:A:947:HOH:O	1.86	0.59
1:A:73:ARG:NH2	1:A:77:GLU:OE1	2.39	0.56
1:A:334:GLU:HG2	1:A:416:MET:HE1	1.86	0.56
1:A:136:ASP:OD2	1:A:184:ARG:NH2	2.40	0.55
1:A:694:ASP:OD2	1:A:725:ARG:NH2	2.36	0.54
1:A:168:THR:HG22	1:A:171:GLU:H	1.73	0.52
1:A:741:ARG:NH2	2:A:801:HOH:O	2.20	0.51
1:A:494:GLU:HA	1:A:494:GLU:OE1	2.11	0.49
1:A:300:PRO:HB2	1:A:493:PRO:HB2	1.93	0.49
1:A:23:VAL:HG22	1:A:34:LEU:HD11	1.95	0.48
1:A:55:HIS:HD2	2:A:1180:HOH:O	1.97	0.48
1:A:646:ARG:HD3	1:A:646:ARG:HA	1.60	0.48
1:A:144:LEU:HD21	1:A:173:HIS:HB2	1.96	0.48
1:A:363:TYR:CE1	1:A:418:MET:HG2	2.50	0.47
1:A:2:PRO:HB3	1:A:33:TRP:CG	2.50	0.46
1:A:236:PRO:HD2	1:A:261:GLU:O	2.15	0.46
1:A:136:ASP:OD1	1:A:136:ASP:N	2.47	0.46
1:A:724:GLU:H	1:A:724:GLU:HG2	1.36	0.45
1:A:319:VAL:HB	1:A:320:PRO:HD3	1.98	0.45
1:A:236:PRO:HG3	1:A:260:VAL:HB	1.98	0.44
1:A:297:GLY:C	1:A:300:PRO:HD2	2.43	0.44
1:A:166:GLY:HA3	1:A:175:ARG:NH1	2.33	0.43
1:A:288:ILE:HD13	1:A:600:GLN:HB2	1.99	0.43
1:A:464:LEU:HB3	1:A:467:SER:HB2	1.99	0.43
1:A:240:ARG:HD3	2:A:1090:HOH:O	2.18	0.43
1:A:372:GLU:HG2	1:A:373:HIS:N	2.33	0.43
1:A:416:MET:HG2	2:A:1178:HOH:O	2.19	0.43
1:A:170:ARG:HG3	2:A:933:HOH:O	2.17	0.43
1:A:498:ARG:NH2	2:A:819:HOH:O	2.51	0.43
1:A:309:ALA:HB2	1:A:513:VAL:HG21	2.00	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:144:LEU:HD11	1:A:151:LEU:HG	2.01	0.42
1:A:51:ASP:OD1	1:A:51:ASP:N	2.48	0.42
1:A:347:GLY:O	1:A:391:ASP:OD2	2.38	0.42
1:A:342:LEU:HA	1:A:342:LEU:HD23	1.83	0.41

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	A	754/770 (98%)	739 (98%)	14 (2%)	1 (0%)	48 61

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	168	THR

5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	A	585/596 (98%)	559 (96%)	26 (4%)	25 37

All (26) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	28	ARG
1	A	43	GLU
1	A	162	GLU
1	A	168	THR
1	A	169	PRO
1	A	170	ARG
1	A	171	GLU
1	A	175	ARG
1	A	228	VAL
1	A	318	LEU
1	A	348	ASP
1	A	360	LEU
1	A	372	GLU
1	A	391	ASP
1	A	494	GLU
1	A	503	VAL
1	A	562	THR
1	A	576	GLU
1	A	580	ARG
1	A	602	LEU
1	A	667	ARG
1	A	724	GLU
1	A	726	SER
1	A	751	VAL
1	A	753	LEU
1	A	757	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	235	HIS
1	A	575	HIS
1	A	678	HIS

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å ²)	Q<0.9
1	A	756/770 (98%)	-0.68	13 (1%) 69 71	25, 39, 73, 113	0

All (13) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	344	GLU	4.8
1	A	757	THR	4.0
1	A	166	GLY	3.8
1	A	667	ARG	3.8
1	A	724	GLU	3.8
1	A	168	THR	3.5
1	A	123	GLU	3.1
1	A	138	PRO	3.0
1	A	139	ASP	2.9
1	A	141	LEU	2.6
1	A	155	GLU	2.2
1	A	737	ARG	2.1
1	A	717	ASP	2.1

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.